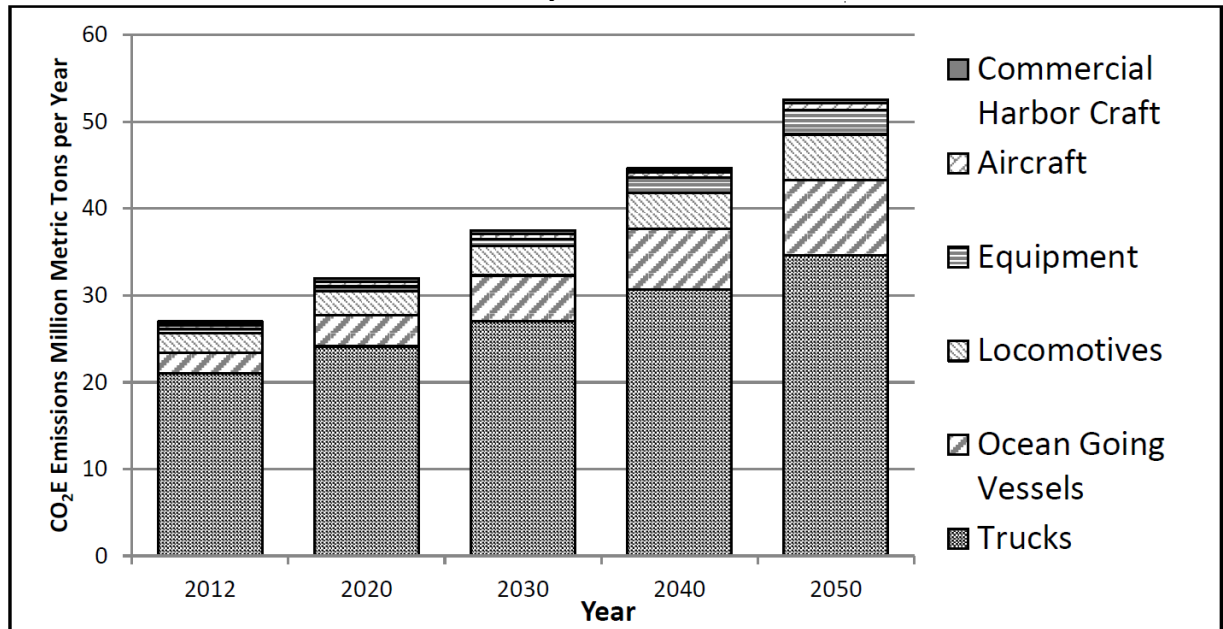


# 1 Background

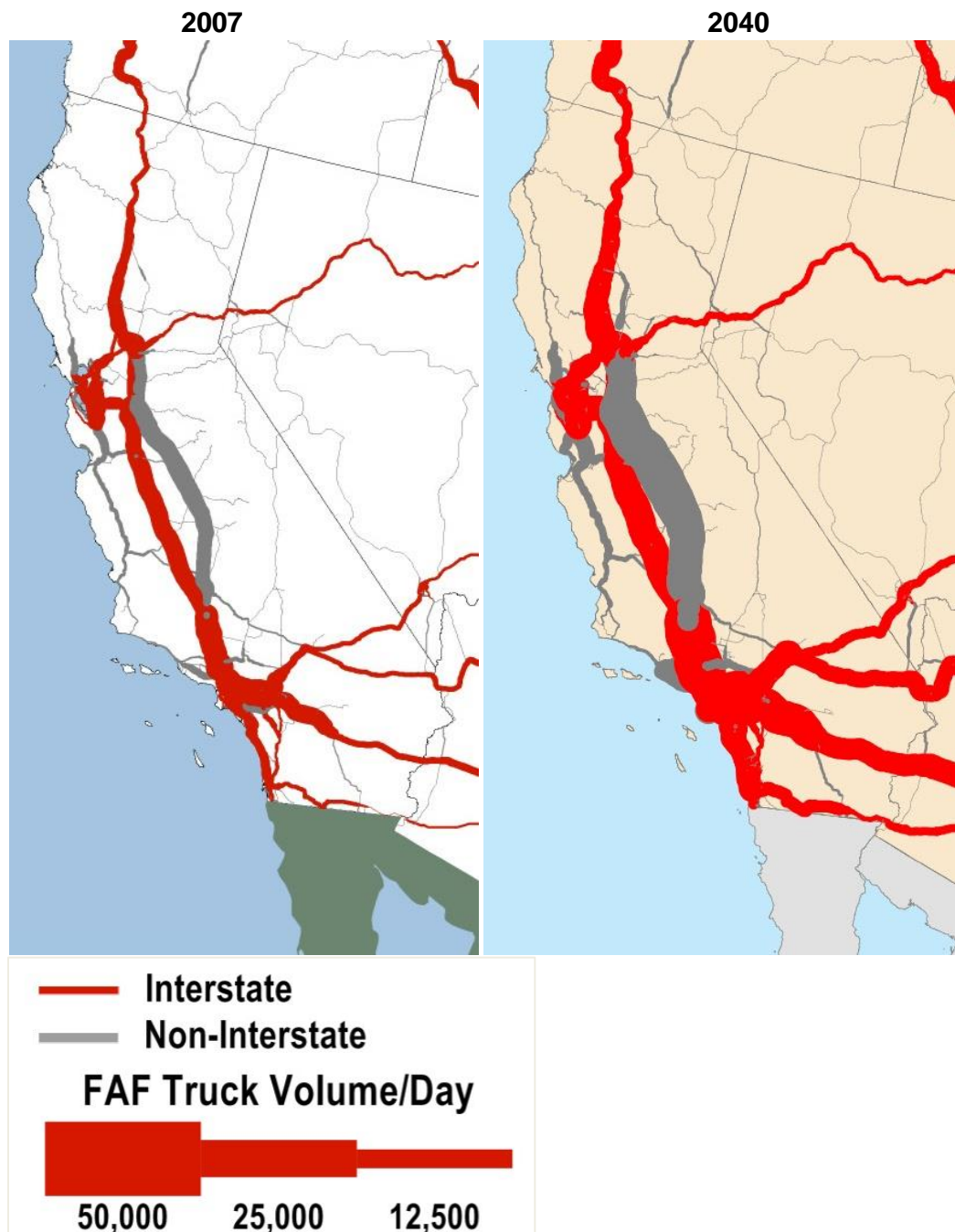
## 1.1 Freight Challenge

- ARB's most recent forecast show GHG emissions from trucks going from about 20 million metric tons CO<sub>2</sub>e in 2012 to nearly 35 MMT CO<sub>2</sub>e in 2050.



\*Ocean-going vessels out to 24 nautical miles.

- Shifting freight to other modes, such as an upgraded rail system, may play a part of the solution.
- That said, road freight is anticipated to remain a large and vital part of the transport system.
- Indirect solutions, such as alleviating congestion by building more roads, are according to the National Center for Sustainable Transportation unlikely to have long run positive effects, since they lead to increased traffic
  - This is sometimes referred to as “the Rebound effect”
- To achieve general goals of cutting petroleum use and GHG, it is imperative that freight trucks are put on a path towards zero emissions.
- ARB writes that “By **focusing** on the **ultimate technology endpoint** (zero emissions) that **satisfies all** of our **air quality goals** and supporting needed engineering advances, we can **provide the certainty businesses need** for long-term planning”. This is necessary both for technology users and for the companies developing solutions when they make investment decisions.



Source: U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, *Freight Analysis Framework*

## 1.2 Electro-Mobility Solution

- Given the goal of California to generate 50% of electricity from renewable sources, as well as federal plans for decarbonizing power generation, it makes sense to find efficient ways to make this clean energy available to heavy duty trucks.
- Electro-mobility offers a variety of benefits, including improved local air quality and increased energy efficiency, which lowers operating costs.

- The main obstacle to electrify heavy road freight, especially for long-haul, has been the size and weight required for on-board storage of electrical energy.
- This problem can be solved by providing power to the truck as it is driving. These kinds of solutions are collectively known as Electric Road Systems, or ERS, although some refer to them as Dynamic Power Transfer.
- Such systems would be especially well suited to addressing the challenges posed by the main road freight corridors, such as the I-710 and SR-60 connecting the San Pedro Bay Ports with the intermodal rail yards in central LA and in the Inland Empire, as well as the I-5 and SR 99 corridors up and down the State of California.
- Several European nations (e.g. Sweden and Germany) have already concluded that such solutions have great potential. For instance, the German government thinks that upgrading just 6,000 miles of the most densely used highways has potential to cut total road freight emission (i.e. also including urban and regional freight, in addition to long haul), by 60%, if the electricity was generated from renewable sources.

### 1.3 Catenary-hybrid solution

- For reasons of safety, efficiency and reliability, Siemens chose to develop a catenary hybrid solution for ERS, called eHighway
- It is similar to how trains, trams and trolley-buses are powered, but maintaining the flexibility of today's trucks
- The key innovation that enables this new kind of freight system is an active current collector, also known as a pantograph, which enables the truck to connect to and disconnect from the catenary at full speed.

### 1.4 Current Demo Projects

- These Catenary solutions are currently being built to be demonstrated on public roads.
- For example, the Swedish Transport Administration recently announced two demonstration projects, including a freight truck OCS (overhead contact line system) being built by Siemens.
- In Germany, Siemens is also operating a private road, 1.2 mile, OCS test track.
- This led Germany authorities to study the technical feasibility and environmental benefits of this test track.
- Their conclusion led the German federal government to approve plans of a public field trial of our eHighway system.

### 1.5 Carson Demo Project

- Independent reports also confirm the economic and environmental benefits of a catenary solution in California.
- This led the South Coast Air Quality Management District to commission a project, with Siemens, near the ports of Los Angeles and Long Beach in the City of Carson, CA.
- Realization of the project involves vehicles of several different trucks manufacturers, one of which is Mack.

- The goal of the project is to collect data and evaluate the benefits of such a system, especially for highly used road freight operations connecting the ports with local rail yards and logistics centers.

## 1.6 Impact for California Sustainable Freight Strategy

- Much of California's road freight is concentrated on freight corridors, whether it be the I-710, the I-5 or Highway 60, all which help form the backbone of California's freight network.
- The fact that so much road freight takes place on these densely used corridors has been seen as a major challenge towards decarbonized transport. It is however possible to see this concentration of vehicles with high energy consumption and annual mileage as an opportunity.
- A report from Gladstein, Neandross & Associates (GNA) included a road map on how a catenary hybrid system could be introduced, building on the knowledge from public road demonstration project already under way. The Southern California Association of Governments, Regional Transportation Plan 2012 (SCAG RTP 2012) also included a timeline for implementing a very similar Zero Emission Freight System
  - As a first step, a pilot project for shuttle operations, such as drayage from ports to near-dock rail yards could be established
  - Alternatively, just as in Sweden, a demonstration project could be executed on a highway section, to ensure that the highway authorities can thoroughly vet and familiarize themselves with such a solution and its operations.
  - Evaluate results and if promising continue with the second step: expand the existing system if possible, or implement the chosen solution on a larger scale.
  - GNA suggested that a near dock drayage application could be expanded to the I-710. The SCAG RTP 2012 further suggested that the from the I-710 the chosen solution could also be expanded to SR-60
  - Once a regional system is achieved, implementing the solution also on the long distance corridors of California is possible

## 2 Project proposals

### 2.1 Name and contact information.

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 Germany

## 2.2 Project title.

Electric road pilot for zero emission freight corridors

- A) on segment of I-710
- B) in Port of Oakland
- C) on sections of I-5 or State Route 99
- D) on I-710 South
- E) on State Route-60

## 2.3 Location of project

- A) The stretch of I-710 between the Port of Long Beach and up to interchange with Willow St.
- B) Port of Oakland, Maritime St (from Grand Ave) to Middle Harbor Rd, and following Middle Harbor Rd until Adeline St
- C) I-5 or SR-99, A representative highway section with a high density of road freight, Exact location t.b.d.
- D) All of I-710 South, between downtown (near interchange with SR-60) all the way to the San Pedro Bay ports (POLA & POLB)
- E) SR-60, between interchange with I-710 all the way to the San Bernardino intermodal facility

## 2.4 Concise two paragraph executive summary of project.

- A) Establishing an electric road system on a core freight corridor, linking the Long Beach Container terminal with the near dock rail yards (ITCF and proposed SCIG).
- B) Linking the north and south part of Port of Oakland with an Electric Road System, enabling Zero emission trucks to bring goods back and forth.
- C) Demonstrating an Electric road on one of the two most important road freight corridors in California, for the purpose of vetting and evaluating the technology's suitability and potential to address the challenge of long haul road freight
- D) The planned upgrading of the I-710 provides a unique opportunity to both address the severe air quality and GHG problems along the country's most densely used freight corridor as well as establishing/introducing a road freight solution that can be expanded to other corridors in L.A., California and beyond. By installing overhead contact lines (catenary) along the I-710, and supporting the use of catenary hybrid-trucks, a zero-emission freight corridor can be achieved, while at the same time greatly reducing vehicle operating costs.
- E) Establishing a Zero emission freight system for trucks, as proposed in the Southern California Association of Governments, Regional Transportation Plan 2012 (SCAG RTP 2012)

## **2.5 Detailed description.**

### **2.5.1 Advanced technologies, alternative fuels, freight and fuel infrastructure**

The outline of an Electric Road System (ERS), as well as the Siemens ERS-solution with catenary hybrid trucks have been described in the preamble section. Additional information is available in the attached Siemens eHighway Brochure and a technical paper Siemens submitted to the Transport Research Board.

### **2.5.2 Local economic development**

The first order effect of implementing a zero emission freight corridor would be to lower the operating costs, since the ERS would have an electrical energy efficiency of close to 85% compared to the ca. 40% energy efficiency of a diesel combustion engine.

Second order effects would be that future growth of the freight sector in California can be much more easily reconciled with the requirements for improved air quality. This will enable ports, rail yards and other businesses along the logistics chain to grow, boosting jobs and incomes.

A third order effect would be to increase the attractiveness to live and work in the nearby communities. This too would increase economic opportunities.

### **2.5.3 Improving freight efficiency**

Freight efficiency increased by boosting operating margins, thanks to lower operating costs. Cost stability / predictability would be much higher, since electricity prices are less volatile than diesel prices, and due to higher efficiency of an electric engine the impact of fuel cost is only half as strong as with diesel motors.

Tractor operating life could be extended, given the longer lifetime and lower maintenance need of electric engines.

Eliminating NOx, SOx, PM and CO2 emissions could also be considered an improvement in efficiency.

### **2.5.4 Transition to zero emission technologies**

Transition to zero emission technologies is supported in two ways. One is that the kind of infrastructure applied in one project could be extended to organically develop a network of zero emission road freight corridors. The second way concerns the kind of hybrid trucks. Initially these could be a combination of combustion-hybrids (like the Mack truck in the AQMD-funded demonstration project in Carson) and battery-electric hybrids (like the TransPower truck, which is part of the same project). As zero emission technologies for driving outside of the electric road mature, the trade-off between extent of the ERS-network and the size of on-board energy storage will be clearer.

### **2.5.5 Increasing competitiveness of California's freight system**

By lowering operating costs, addressing air quality concerns and future proofing California's freight system to concerns about GHG emissions, a Zero-emission road freight system based on electric roads would ensure California can remain the leading freight hub in the nation.



## 2.6 Estimated cost for implementation and existing funding commitments (include any funding limitations or constraints) by stakeholder and amount.

A study of the Zero-Emission Catenary Hybrid Truck Market by Gladstein, Neandross & Associates (GNA), funded by the South Coast Air Quality Management District estimated the cost of implementing catenary infrastructure (including power supply from substations) on existing highways to USD 5-6 million per mile.

If the infrastructure was build in conjunction with other civil work, say the proposed I-710 expansion, then some costs savings could be possible.

The main costs related to the infrastructure occurring as the infrastructure is built, but can be recouped from usage fees over the long life time (35+ years).

The GNA report also estimates costs for small series production of vehicles to be around 120,000 USD extra per truck, compared with current diesel trucks. Given current legislation pushing for much stricter fuel economy and emission standards in the coming decade or so, it is likely that more trucks will become hybridized. That would lead to an even lower cost gap between ERS-adapted trucks and the rest.

Several sources of funding could be allocated to such a project, for instance the HVIP might be used to cover some part of the initial vehicle investment.

## 2.7 Timeline.

- a) Spring 2016: CSFS commissions a study on electric road technologies, their recent progress and the potential for California heavy road freight. This could be done by ARB, which already prepares assessments of various technologies (Battery electric, fuel cells, etc)
- b) Summer 2016-Summer 2017: Consider including an ERS pilot or demonstration project in the California Sustainable Freight Action Plan. This could be done in a technology open way, like the Swedish Pre-Commercial Procurement process. It contained four steps
  - a. Invite all interested parties to explain why they are qualified to execute such a project (criteria in Sweden were quite generous, in that only partial experience with a single part, say electric drive trains or power supply, were sufficient to be invited to the next stage)
  - b. Invite qualified participants to submit proposals on what kind of ERS project they would like to execute (what technology, where, with whom) and what knowledge would be generated that could help California evaluate if ERS makes sense for its road freight corridors
  - c. Select the most promising ideas and provide them with support to make detailed designs of their initial proposals
  - d. Select one or two projects for implementation

As for I-710 the timeline can be further detailed as follows:

- c) All of 2016: Ensure that the I-710 EIR keeps the option open to include a zero emission freight system. In Early 2017 a preferred alternative should be selected.

- d) Early 2018 the final EIR should then be completed.
- e) 2018-2019(?): Detailed design of I-710 corridor project
- f) 2019-2022(?): Building catenary infrastructure and its power supply
- g) 2021-2025(?): Vehicle production, gradually increasing

Note however, that the milestones are only indicative as essential decisions remain to be taken.

## **2.8 Means for measuring progress toward meeting goals over time.**

- a) ARB, Caltrans or other State Agency conducting a feasibility study on Electric Roads
- b) Pilot ERS project procured (perhaps via Pre-Commercial Procurement, like done by the Swedish Transport Administration). Illustrating how the project would progress over time can be done by considering aspects required for a successful commercial system on the I-710
  - a. Getting included in the I-710 EIR
  - b. PPP partners on-board:
    - i. Drayage operator(s)
    - ii. Utility/catenary system operator
    - iii. vehicles supplier(s)
  - c. Detailed designs approved
  - d. Catenary infrastructure construction begins
  - e. Vehicle production begins
  - f. Commissioning of infrastructure and vehicles
  - g. Operations
- c) Additional systems implemented, either as extensions of pilot system or as independent systems
- d) Expand systems to regional ERS-network
- e) Expand from regional ERS-networks to state-wide ERS, via I-5 and SR-99

## **2.9 Description of the potential roles each of the interagency partners could provide to support the project's implementation.**

Caltrans: As the main owner and operator of California's highway system, it is imperative that Caltrans becomes familiar with the ERS technology and to engage with industry (infrastructure and vehicle suppliers) to clarify issues and concerns, with the goal of enabling Caltrans highways to be equipped with catenary.

California Energy Commission: Analysis of impact of large scale ERS compared with other solutions for zero emission road freight.

US EPA and California Air Resources Board: Vehicle certification

Cal. EPA and California Air Resources Board: Analysis of long term options for cost efficient zero emission road freight.



California Governor's Office of Business and Economic Development (GO-Biz): Analysis of long term options for cost efficient zero emission road freight.

### **3 Additional information may be attached. Please note that any information provided is considered public.**

Siemens eHighway brochure

Siemens technical paper submitted to the Transport Research Arena

Presentations regarding Electric Roads from an event at the International Transport Forum in Leipzig, Germany, 2015: [http://2015.internationaltransportforum.org/electric-roads#node\\_ifi\\_events\\_full\\_group\\_link](http://2015.internationaltransportforum.org/electric-roads#node_ifi_events_full_group_link)

"Possibilities for Electrification of the TEN-T Corridors [of the European transport network]" by Magnus Henke of the Swedish Energy Agency:

<http://www.slideshare.net/EuropeanCommission/innovation-and-new-technologies-innovation-pipelines-from-research-to-market-roll-out-m-henke>

International Council on Clean Transportation blog: Is there an e-Autobahn in our future?

<http://theicct.org/blogs/staff/future-of-e-autobahn>

Southern California Association of Governments, Regional Transportation Plan 2012:

<http://rtpscs.scag.ca.gov/Documents/2012/final/f2012RTPSCS.pdf>

Gladstein, Neandross & Associates, Zero-Emission Catenary Hybrid Truck Market Study

<http://www.gladstein.org/pdfs/ZETECHMarketStudy.pdf>

California Air Resources Board, Sustainable Freight, Pathways to Zero and Near-Zero Emissions, Discussion Draft, April 3, 2015.

[http://www.arb.ca.gov/gmp/sfti/Sustainable\\_Freight\\_Draft\\_4-3-2015.pdf](http://www.arb.ca.gov/gmp/sfti/Sustainable_Freight_Draft_4-3-2015.pdf)

National Center for Sustainable Transportation - Increasing Highway Capacity Unlikely to Relieve Traffic Congestion [http://www.dot.ca.gov/research/docs/10-12-2015-](http://www.dot.ca.gov/research/docs/10-12-2015-NCST_Brief_InducedTravel_CS6_v3.pdf)

[NCST\\_Brief\\_InducedTravel\\_CS6\\_v3.pdf](http://www.dot.ca.gov/research/docs/10-12-2015-NCST_Brief_InducedTravel_CS6_v3.pdf)